

search the ground round about. They then draw whatever vegetable material they can find into their tubes—fallen stems and leaves and small branches. In the morning one then finds little heaps of plant-fragments projecting at various parts of the surface, and each of them penetrating the tube of a worm. On closer examination it is found that the leaves have each been rolled together by the worm, and then drawn into the tube in such a way that the leaf-stalk projects. The portion of the leaf in the tube is moist and softened, and only in this state are plants consumed by the worm. There are distinct indications that the worm gnaws them, and after some days the meal is ended. The food is never drawn deeper down into the ground. In digging the ground at various seasons it was only very rarely that plant remains were found in the subsoil, and probably they got there by accident.

With reference to the structure of the worm-tubes, some interesting facts were established in these researches. In humus their character is difficult to make out, owing to the looseness of the mass. In sand they proceed almost vertically downwards three, four, or even six feet, whereupon they often extend some distance horizontally; more frequently, however, they terminate without bending. At the end of the tube the worm is found with his head upwards, while round about him the tube is lined with small stones. On the sandy wall of the tube one observes more or less numerous black protuberances which make the sand fertile. These are the secretions of the worm, which, after being removed out of a tenanted tube, are found next morning replaced by fresh matter. They are observed after a few days, when a worm is put in a vessel with clean sand, and allowed to make a tube for itself. Older abandoned tubes are pretty regularly lined with the earth formed by the worm, and some passages are densely filled with black earth. This black substance appears to diffuse somewhat into the sand.

In about half of the tubes, not quite newly made, M. Hensen found roots of the plants growing at the surface, in the most vigorous development, running to the end of the tube and giving off fine root-hairs to the walls, especially beautiful in the case of leafy vegetables and corn. Indeed such tubes must be very favourable to the growth of the roots. Once a root-fibre has reached such a tube it can, following the direction of gravity, grow on in the moist air of the passage, without meeting with the least resistance, and it finds moist, loose, fertile earth in abundance.

The question whether all roots found in the under-soil have originally grown in the tubes of worms, cannot be answered with certainty. It is certain that the roots of some plants penetrate themselves in the sand, but not to great depths. M. Hensen is of opinion that the tap-roots, and in general such root-forms as grow with a thick point, can force a path for themselves, while the fine and flexible suction-roots have difficulty in obtaining a path into the depths other than what has been previously made for them. Roots of one year's growth especially can penetrate deep into the sub-soil, only where there are earth-worms.

A microscopical comparison of the earth deposited by the worm shows that it is like the two-year leaf-mould prepared by gardeners for the filling of flower-pots. Most of the plant-cells are destroyed; still there are present some cells and shreds of tissue, browned and friable, mixed with many sand grains and brown organic fragments. The chemical composition of the worm-earth shows much similarity to that of fertile humus ground. Its fertility, therefore, cannot be doubted, though direct experiments with it are wanting.

With regard to the numerical value of this action of the earthworm, the following observations by M. Hensen afford some information.

Two worms were put into a glass pot $1\frac{1}{2}$ foot in diameter, which was filled with sand to the height of $1\frac{1}{2}$ foot, and the surface covered with a layer of fallen leaves. The worms were quickly at work, and after $1\frac{1}{2}$ month many leaves were down 3 inches deep into the tubes; the surface was completely covered with humus 1 cm. in height, and in the sand were numerous worm-tubes partly fresh, partly with a humus wall 3 mm. thick, partly quite filled with humus.

Counting, when an opportunity offered, the open worm-tubes in his garden, M. Hensen found at least nine in the square foot. In 0.15 square metres two or three worms were found in the deeper parts each weighing three grammes: thus in the hectare there would be 133,000 worms with 400 kilos. weight. The weight of the secretions of a worm in twenty-four hours was 0.5 grammes. While these numbers are valid only for the locality

referred to, they yet give an idea of the action of this worm in all places where it occurs.

The assertion that the earthworms gnaw roots is not proved by any fact; roots gnawed by worms were never met with, and the contents of the intestine of the worms never included fresh pieces of plants. The experience of gardeners that the earthworm injures pot plants may be based on the uncovering or mechanical tearing of the roots.

"Let us take a retrospective glance," concludes the author, "over the action of the worm in relation to the fertility of the ground. It is clear that no new manure material can be produced by it, but it utilises that which is present in various ways. 1. It tends to effect a regular distribution of the natural manure material of fields, inasmuch as it removes leaves and loose plants from the force of the wind and fixes them. 2. It accelerates the transformation of this material. 3. It distributes it through the ground. 4. It opens up the undersoil for the plant roots. 5. It makes this fertile.

UNIVERSITY AND EDUCATIONAL INTELLIGENCE

OXFORD.—The University Commissioners are at present occupied in taking evidence on the subject of University requirements. The Dean of Christ Church, the Master of Balliol, the Master of University, the Librarian of the Bodleian, Profs. Clifton, Bonamy Price, Bartholomew Price, Stubbs, and others have appeared, or are to appear during the present week, before the Commissioners.

Mr. Lazarus Fletcher, B.A., of Balliol, has been elected to the vacant Fellowship at University College. Mr. Fletcher obtained a first class in the School of Mathematics in 1875, a first class in that of Natural Science in 1876, and the senior mathematical scholarship in 1876.

It is proposed to found a high school for the City of Oxford, the mayor, aldermen, and citizens having long felt it a reproach that, being the site of one of the most ancient and famous of the Universities of Europe, it has been absolutely without any recognised grammar school available for the sons of the citizens.

LONDON.—Prof. W. K. Clifford, F.R.S., is at present delivering at University College a very interesting course of Lectures on Quaternions. The main object of the course is to bring the physical applications of quaternions as much as possible within the reach of mathematicians of moderate attainments.

A requisition is in course of signature to the chairman of Convocation of London University, Dr. Storrar, asking that an extraordinary meeting of that body may be convened for the purpose of considering and discussing the following resolutions, and for deciding with reference thereto in such manner as to Convocation may seem fit:—"That it being manifestly inexpedient that frequent application should be made to the Crown for new and additional charters, it is desirable that provision should be made in any such charter for all changes in the constitution of the University, either at the time urgent or likely to be soon required; and that it being probable that initiative measures will be shortly taken towards procuring such a new or additional charter, the following proposals require the serious consideration of Convocation and the Senate:—(1) An enlargement of the powers directly exercised by Convocation; (2) An increase in the proportion of senators to be nominated or elected by Convocation, and the limitation of the tenure of office in the case of all senators to a term of years; (3) The encouragement of mature study and original research among the members of the University, by the establishment of University lectureships, of limited tenure, in different departments of learning and science; (4) The introduction into the constitution of the University of such modifications as may remove all reasonable ground of complaint, on the part of any of the affiliated colleges, with respect to the absence of means for expressing opinion and giving advice to the Senate on the examination regulations, and on the changes proposed to be made therein from time to time. And that a Special Committee of ten members of Convocation be appointed to consider the above-mentioned proposals, and to report thereon to Convocation as speedily as possible."

The Entrance Science Scholarships in St. Thomas's Hospital have been awarded this year as follows:—The Scholarship of 60*l.* to Mr. Wansborough Jones, B.A. Oxon., and B.Sc., London; and that of 40*l.* to Mr. A. E. Wells.

BRISTOL.—A well-printed and well-arranged Calendar of University College has been published. It extends to upwards of sixty pages, and contains all the information usually found in such publications, including full details as to the Medical School.

Dean Stanley's address on Education, at University College, on Saturday, attracted an audience of about 1,700 people, who listened with the closest attention.

SCIENTIFIC SERIALS

Kosmos, Part 2 (May) opens with an article by L. Overzier, on "Heredity" (Part I), aiming at the discovery of the real cause of inheritance.—Prof. Jäger, commencing a series of articles on "The Origin of Organs," deals with the development of the eye, showing how the laws of optics and the properties of living substance mutually influence one another.—Hermann Müller, treating on "The Origin of Flowers," considers the first metaspERM (or angiosperm) to have been diclinous and fertilised by the wind, that is, supposing the metaspERMS to have originated from a single stock.—W. O. Focke deals with "The Conception of Species in the Vegetable Kingdom," especially in relation to the genus *Rubus*. He shows how far the different species are from being of equivalent value and that the term variety has no definite significance. He exposes the futility of much botanical "research," owing to imperfection of methods and lack of comparative study; Darwin has few imitators. Such work requires an entire devotion of time and complete botanical gardens, for the multiplication of which the author calls.—A. Lang, on Lamarck and Darwin (I.), expounds Lamarck's conceptions of natural history.

Kosmos, Part 3 (June).—L. Overzier continues his discussion of heredity, reviewing Darwin's theory of pang-nesis, Haeckel's perigenesis, and Jäger's chemical theory; he considers the latter to be of great value.—Carl du Prel, on the needed remodelling of the nebula hypothesis.—Prof. Jäger treats of the origin of the organ of hearing, tracing it from the simplest condition where spicules diffused through the entire protoplasmic body of an animal serve to gather up and conduct vibrations of sound. He brings forward the remarkable theory that in animals possessing nerve fibres, the organs of hearing is but a specialisation from the general tactile sense.—W. von Reichenau, on the colours of bird's eggs, makes the generalisation that birds having open nests have coloured eggs, while those with covered or concealed nests have white ones; further, that in open and ground nests the colour of the eggs has a protective object.—A. Dodel-Port, on the lower limit of sexuality in plants, gives an account of the sexual processes in *Ulothrix zonata*, but appears not to have heard of the researches of Dallinger and Drysdale on the monads.—A. Lang, on Lamarck and Darwin, expounds Lamarck's "hydro-geology."

SOCIETIES AND ACADEMIES

PARIS

Academy of Sciences, October 22.—M. Peligot in the chair.—The following papers were read:—M. Leverrier's tables of Uranus and Neptune, by M. Tresca.—On some applications of elliptic functions (continued), by M. Hermite.—*Résumé* of a history of matter (first article), by M. Chevreul. This is an extract from a work commenced about the end of last year, and occupying 418 pages of the *Mémoires de l'Académie*, t. xxxix. A sketch of the principles of alchemy is given.—On one of the causes of red coloration of the leaves of *Cissus quinquefolia*, by M. Chevreul. This cause is sunlight. The green colour is retained in the leaves that are shaded by others.—On the order of appearance of the first vessels in the shoots of some Leguminosæ, by M. Trécul.—Modifications in the conditions of maxima of electro-magnets by the state of more or less complete saturation of their magnetic core, by M. Du Moncel. The law of proportionality of the attractive forces to the squares of the intensities of the current is true only within certain limits, and under certain conditions; and electro-magnets through which the current is interrupted at very short intervals, are (more or less) not subject to it. When the forces are proportional to (say) the cubes of the electric intensities, the helices must always be less resistant than the exterior circuit. In the case of multiplied interruptions, the resistance of electro-magnets must always be less the shorter the duration of closures of the current; and for this reason (also because of defective insulation and extra currents) telegraph electricians reduce considerably the resistance of electro-magnets applied to long circuits. Reverting to the

question in the title, the thickness of the magnetising spiral may be increased in case of defective saturation of the magnetic core; becoming double the diameter of this if the force increases as the cube of the intensities.—Preparations of sulphide of carbon brought to the solid state by means of gelatine, by M. Cassius. 100 grammes of gelatine are dissolved in 1,000 grammes of water, and sulphide of carbon (25, 50, or 75 per cent.) is mixed at a temperature of 15° to 20°, and the mixture let cool. M. Cassius thinks the preparation might be useful in viticulture. The sulphide is liberated slowly, the time varying according to the proportion of sulphide absorbed.—Experiments on the formation of artificial ultramarine, by M. Plicque. He finds (in opposition to some German authors) that ultramarine does not contain nitrogen. Blue ultramarine, properly so called, is formed by an oxygenated compound of sulphur, and it is probable that this compound is fixed both by sodium and by aluminium.—On the catechines and their constitution, by M. Gautier.—On acid acetates, by M. Villiers. The increase of weight of some neutral acetates, dried and placed, in a summer month, under a bell jar with crystallisable acetic acid, was, in the case of acetate of soda, 404 per cent., or nearly six equivalents of acetic acid; acetate of potash, 264 per cent.; of baryta, 179 per cent.; of lead, 134 per cent., &c. The solutions of neutral acetates in crystallisable acetic acid have much less tension of vapour than that of acetic acid.—Researches on butylene and its derivatives, by M. Puchot.—Note on the cause of anthrax, by M. Klebs.—On the structure of the blood corpuscle, and the resistance of its envelope to the action of water, by MM. J. Bechamp and Baltus. The demonstration of the membrane (by action of soluble fecula) is here given in the cases of the frog, the ox, the pig, and the sheep. Water does not destroy the globules; it merely renders them invisible, and they may always be discovered with the aid of picrocarmine, even in extremely dilute media, and after several weeks of contact. The blood of sheep (like that of the hen in M. A. Bechamp's experiments) contains globules of more delicate structure than those of the other bloods examined.—Researches on the functions of leaves of the vine, by M. Macagno. Glucose and tartaric acid are formed preferably in the upper leaves of the fruit-bearing vine-branch; this production of sugar progresses with that of the grape, and is much reduced (even to disappearance) after the vintage. The green branches are conductors of glucose. These facts explain the evil of "pinching" or removing the tops of the grape-bearing branches, with too great zeal. Where there is an abundant production of grapes, a sufficient quantity of leaves should be left for preparation of the necessary glucose.—Reply to a recent note of M. Buys Ballot, on the division into time and into squares of maps of nautical meteorology, by M. Brault.

CONTENTS

PAGE

THE SUN'S DISTANCE	1
PARKER AND BETTANY'S "MORPHOLOGY OF THE SKULL"	3
THOMSON'S "SIZING OF COTTON GOODS"	4
OUR BOOK SHELF:—	
Aveling's "Physiological Tables for the Use of Students."—A. G.	5
LETTERS TO THE EDITOR:—	
Indium in British Blenders.—Prof. NEVIL STORY MASKELLYNE, F.R.S.	5
The Radiometer and its Lessons.—Prof. G. CAREY FOSTER, F.R.S.; WILLIAM CROOKES (The Ortho-Crookes?), F.R.S.	5
Mr. Wallace and Reichenbach's Odyle.—ALFRED R. WALLACE; Dr. WILLIAM B. CARPENTER, F.R.S.	8
Potential Energy.—E. G.	9
Hartlaub's "Birds of Madagascar."—Prof. ALFRED NEWTON, F.R.S.	9
Eucalyptus.—Prince PIERRE TROUBITZKOY; ARTHUR NICOLS.	10
Meteor of October 19, 6.15 P.M.—W. F. DENNING (<i>With Illustrations</i>)	10
Curious Phenomenon during the Late Gale.—A. W. B. J.	10
Singing Mice.—HENRY H. SLATER	11
Sound-Producing Arthropods.—W. SAVILLE KENT	11
Insects and Flowers.—A. J. H.	11
FRANCIS VON ROSTHORN. By Prof. E. SUESS	11
SPECTRUM OF AUKORA AUSTRALIS. By Commander J. P. MACLEAR (<i>With Illustration</i>)	11
ABSOLUTE PITCH. By Lord RAYLEIGH, F.R.S.	12
A NEW CONDENSING HYGROMETER. By M. ALLUARD (<i>With Illustration</i>)	14
OUR ASTRONOMICAL COLUMN:—	
Early Observations of the Solar Corona	14
The Outer Satellite of Mars	15
De Vico's Comet of Short Period	15
METEOROLOGICAL NOTES	15
NOTES	16
AMERICAN SCIENCE	18
THE EARTHWORM IN RELATION TO THE FERTILITY OF THE GROUND	18
UNIVERSITY AND EDUCATIONAL INTELLIGENCE	19
SCIENTIFIC SERIALS	20
SOCIETIES AND ACADEMIES	20